Enhancing Student Success through a Model *Introduction to Engineering* Course

Instructor's Guide

Studying Engineering: A Road Map to a Rewarding Career, 3^{rd} *Edition*

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Instructor's Guide

Studying Engineering: A Road Map to a Rewarding Career

Third Edition

<u>Author's note</u>: This version of the Instructor's Guide incorporates feedback and approaches I received from a number of individuals. The text specific material such as the power point lectures and the multiple choice exams in the appendices have been updated to support use of the 3rd Edition of *Studying Engineering*. The Guide brings together materials from a number of sources, including my ASEE papers on pedagogical approaches for working to with students to change their attitudes and behaviors and past issues of my *Success 101* newsletter. The complete versions of these publications are available at: http://www.discovery-press.com. I continue to view the Guide as a "work in progress" and would welcome your feedback, particularly descriptions of innovative approaches you have used to accomplish one or more of the 23 behavioral and attitudinal objectives presented in the Guide. I'd love to hear from you. Contact me at: <u>rlandis@calstatela.edu</u>.

Ray Landis
March 2007

<u>Overview</u>

This Guide is designed to support an "Introduction to Engineering" course that uses the 3rd Edition of my book *Studying Engineering: A Road Map to a Rewarding Career*. Some of the material is specific to that textbook, but much is not. For example, the sample syllabus in Appendix A, the PowerPoint presentations in Appendix B, and the multiple-choice exams in Appendix C are all specific to my textbook. Most of the material in the body of this Guide addresses course objectives and approaches for accomplishing those objectives, regardless of the text used. However, *Studying Engineering* is unique in that it is the only text I know of that attempts to develop engineering students into "self-growers" in the process of "success." And it does provide persuasive content and practice exercises to help achieve the attitudinal and behavioral objectives outlined in this Instructor's Guide.

The spirit of an "Introduction to Engineering" course focused on "student development/student success" is perhaps best described by the Chinese proverb:

Give a man a fish and you feed him for a day.
Teach a man to fish and you feed him for a lifetime.

In an excellent article in the Fall 1997 issue of the *Success 101* newsletter, Richard Felder of North Carolina State University put it this way:

> **<u>Principle 1</u> - *Entering first-semester college students were high school students three months earlier.***
>
> Many high school students are mature, thoughtful, and industrious, but those are probably not the first three adjectives that come to mind if you are trying to describe the species collectively. A sizable percentage of high school students lack the sound judgment, sense of responsibility, and work ethic needed to do well in a curriculum as demanding as engineering, and they're not likely to magically acquire these things in the summer between high school and college. A great deal of the well-publicized first-year attrition from engineering undoubtedly stems from the assumption that freshmen should be capable of functioning like seniors from the word go. That's a really bad assumption.

[See: www.discovery-press.com/discovery-press/newsletters/1997fall.asp]

The Preface from the First Edition of *Studying Engineering,* builds on Dr. Felder's astute observation as follows:

> We aren't born knowing how to be effective. We learn how. We learn from our parents or guardians, from our teachers, from our peers, and from supervisors and mentors. We learn from workshops and seminars, from books, and from trial and error. Developing our effectiveness is a life-long process. Sometimes we get more help than other times. For example, when we join an organization as a professional, we generally receive lots of help. The organization benefits if we are successful, and so it takes steps to ensure that we are.
>
> Industry executives are well aware that new engineering graduates have a long way to go before they can "earn their salary." New engineering hires are thus provided with formal training, on-the-job training, close supervision, progressively more challenging assignments, rotating work assignments, and time to mature.
>
> Strangely, when new students (or, in fact, new faculty) come to the university, they are left primarily on their own to figure out how to be successful. Academic organizations seem more interested in evaluating their newest members than in doing things to ensure that they succeed.
>
> Within engineering education, this "sink or swim" approach is not working. Only about 40 percent of students who start engineering study ever graduate. Most drop out, flunk out, or change their majors. And many of those who do graduate fail to work up to their full potential.
>
> Even deans of engineering need training. As a new dean, I had four separate consultants in for two days each to teach me (and my school's faculty) how to be effective in preparing for our upcoming accreditation process. In addition, I have

participated in formal training in personnel management, fund raising, Total Quality Management, computer technology, and teaching methods.

If new engineering graduates and new engineering deans need orientation, training, mentoring, and time to mature to be effective, how is it that as engineering educators we expect our students to know how to go about the task of engineering study the day they arrive?

Introduction

Whether we need to bring about greater success on the part of engineering students is not the topic of this document. The fact that we do is assumed to be self-evident. We only have to consider the anecdotal statements of engineering professors that "students aren't what they used to be," or measure our graduates against the outcomes established by the ABET Engineering Criteria 2000, or look at the low transfer rates of students who start engineering study in community colleges, or look at the differentially low retention of minority students (African American, Hispanic, and Native American) to convince ourselves that there is lots of room for improvement. If that's not persuasive enough, we can always take the TQM view that "no matter how good we are doing, we should always strive to do better."

Unfortunately, when we do strive to do better, we often miss the mark. Most institutional strategies aimed at improving student success are oblique. Examples of approaches taken are: increasing moneys available for scholarships; conducting effective teaching workshops for faculty; improving the quality of academic advising; establishing tutorial programs; revising the curriculum to provide freshman students increased exposure to topics such as computing, engineering graphics and design, problem solving, and creativity.

Generally, little consideration is given as to whether these activities and interventions really address those factors that are impeding student success. Consequently, although worthwhile, the types of interventions listed above do not generally have a significant impact on student success. The postulate of this guide is that enhancing engineering student success can best be accomplished by taking a direct approach to changing student ***attitudes*** and ***behaviors***. An Introduction to Engineering course can be a powerful vehicle for doing this.

Achieving this potential starts with the vision of the course instructor. Here's the one I would recommend:

> If I can have quality time with a group of students, I can create a major "life changing" experience for those students—one that will significantly enhance their success.

The Introduction to Engineering course is unique in that it is perhaps the only course in the engineering curriculum for which such a vision would be appropriate. Try applying this vision to other courses you teach. I expect it doesn't fit.

Once you buy into the vision, everything else is easy. All that's left is for you identify the attitudes students need to hold and the behaviors students need to practice to be successful in math/science/engineering coursework and put your problem-solving skills to work in getting them. If students aren't working up to their potential, it's almost certainly because they don't hold these attitudes and don't practice these behaviors.

And the good news is that almost any direct approach to changing students' attitudes and behaviors will work. If you're clear on what you want and go for it, you're almost sure to get it. As an example, let's imagine you believe students should work collaboratively with other students in their key math and science classes. How could you find out whether they are or are not? If you find out they're not, what would be an approach for getting them to do so?

Course Objectives

"Enhancing student success" means changing student attitudes and changing student behaviors. An effective "student success" course focuses on bringing about behavioral and attitudinal changes in areas related to five key themes:

1. Community building
2. Professional development
3. Academic development
4. Personal development
5. Orientation

In order for you to personally assess the potential benefit of a "student success" course, you are encouraged to consider the behavioral and attitudinal objectives listed below from three perspectives:

1. Would students be more successful if they held these attitudes and practiced these behaviors?
2. Do your students currently hold these attitudes and practice these behaviors?
3. If your answer to #1 is "Yes" and your answer to #2 is "No," do you believe that it would be possible to achieve the objectives listed below?

1. COMMUNITY BUILDING

Students in the "Introduction to Engineering" course make up a supportive learning community.

1A. Socialization—Each student in the class knows every other student in the class.

1B. Group building—Students have a strong sense of group and are committed to a high level of mutual support.

1C. Human relations training—Students have the interpersonal skills necessary to interact with each other in a positive and effective manner.

2. PROFESSIONAL DEVELOPMENT

Students are motivated by a clear understanding of engineering as a profession. Students conduct themselves ethically and in a professional manner at all times.

2A. Motivation—Students are highly motivated through a clear understanding of the rewards and opportunities success in engineering study will bring to their lives.

2B. Understanding the essence of engineering—Students can give an articulate response to the question "What is engineering?"

2C. Global awareness of engineering—Students are aware of the various academic disciplines and job functions of engineering.

2D. Industry practice—Students are aware of the various industry sectors (e.g., computer, aerospace, electronic, utility, oil, large constructors, etc.) and of how engineers are utilized in each of these sectors.

2E. Professional student organizations—Students recognize the value of actively participating in student organizations, particularly those related to their chosen profession (ASME, ASCE, IEEE, etc.) and seek to take on leadership roles in those organizations.

2F. Ethics and professionalism—Students are aware of good ethical and professional practice and engage in such practice at all times.

3. ACADEMIC DEVELOPMENT

Students know about and put into practice positive attitudes and productive behaviors that will result in academic success.

3A. Time on task—Students manage their time so as to devote an appropriate amount of time and effort to studying and are operating under the principle that they master the material covered in each class period before the next class period comes.

3B. Interaction with peers—Students make effective use of their peers by frequent sharing of information and by regularly engaging in group study and collaborative learning.

3C. Interaction with faculty—Students interact regularly with their professors both in the classroom and outside of it, positively and with benefit.

3D. Campus resources—Students are aware of and make optimal use of campus resources (e.g., writing center, counseling center, health center, library, placement center, etc.).

3E. Time on campus—Students are aware of the importance of being immersed in the academic environment so that they can take full advantage of the resources available to them, and therefore spend as much time on campus as possible.

3F. Other study skills—Students are aware of and practice good study skills in other areas (e.g., note taking, test taking, etc.).

4. PERSONAL DEVELOPMENT

Students have a good understanding of and feel good about themselves and their educational experience. Students interact well with and respect others, engage in good health and wellness practices, and effectively manage the various aspects of their personal life.

4A. Understanding of self—Students' personality types and learning styles have been assessed using standard instruments, and they have a strong understanding of themselves as unique individuals.

4B. Self-confidence and self-esteem—Students feel good about themselves and their situation, and are confident in their ability to succeed academically.

4C. Self-assessment—Students have clear goals and have a plan for their personal development based on a self-assessment of their strengths and weaknesses.

4D. Wellness and stress management—Students engage in good health and wellness practices and know how to manage stress through stress-reduction methods.

4E. Respect for and interaction with others—Students value and respect differences in people and interact effectively with people of all cultures, ethnicities and genders.

4F. Management of personal life—Students are effective in managing the various aspects of their personal life, including interaction with family and friends, personal finances, work load, etc.

5. ORIENTATION
Students understand how the engineering college and the university work and how best to take advantage of the resources available to them.

5A. College of Engineering—Students understand the organizational structure, facilities, resources and regulations of the college of engineering and make effective use of them.

5B. University—Students understand the organizational structure, facilities, resources and regulations of the university and make effective use of them.

Accomplishing the Objectives – General Methodologies

You're probably thinking "That's a lot of objectives!" It is. Twenty-three to be exact. But the good news is that you don't have to accomplish all of them. Some are much more important than others. So the first step is to make a list in order of importance.

Here's my top five list based on my view of what will be of the most benefit to students.

#1 Socialization (Objective 1A)—Each student in the class knows every other student in the class (at least by first and last name)

#2 Motivation (Objective 2A)—Students are highly motivated through a clear understanding of the rewards and opportunities success in engineering study will bring to their lives

#3 Time on Task (Objective 3A)—Students manage their time so as to devote an appropriate amount of time and effort to studying and are operating under the principle that they master the material covered in each class period before the next class period comes.

#4 Interaction with peers (Objective 3B)—Students make effective use of their peers by frequent sharing of information and by regularly engaging in group study and collaborative learning.

#5 Interaction with faculty (Objective 3C)—Students interact regularly with their professors both in the classroom and outside of it, positively and with benefit.

But you should make up your own prioritized list. Your list is the one you will have the strongest personal commitment to.

So hopefully we have made the list less daunting. Armed with a prioritized list you can just start down the list from your #1 item and do as many as you can. Even if you do two or three well, your students will reap significant benefits.

Typically, accomplishment of these objectives involves changing students in three areas:

- New knowledge
- New attitudes
- New behaviors

As examples, we can take each item from my “top five” list and briefly point to examples of knowledge, attitudes, and behaviors associated with it.

	New Knowledge	**New Attitudes**	**New Behaviors**
Objective 1A Socialization	Names of students in class. Value of students in the class.	I’m going to cultivate relationships with the students from Intro to Engr class.	Interact with students in Intro to Engr course outside of class
Objective 2A Motivation	Rewards and opportunities of engineering.	Nothing is going to keep me from getting my degree in engineering.	Make new agreements with family and friends to gain support for education as priority.
Objective 3A Time on Task	How much time is required. Value of keeping up in classes. Value of scheduling study time.	I’m going to schedule my study time and stick to the schedule.	Study more and in the right timeframe.
Objective 3B Interaction with Peers	Educational value of collaborative learning. Strategies for going about it.	I’m going to find a study partner in each of my key classes.	Engage in group study sessions on a regular basis.
Objective 3C Interaction with Faculty	Benefits of one-on-one instruction. Roles faculty can play outside of instruction.	I’m going to work at building an academic relationship with my professors.	Seek one-on-one instruction during professors’ office hours.

For general guidance, we can again look to Richard Felder’s excellent article from the Fall 1997 issue of *Success 101*:

<u>Principle 2</u> - *Success skills have never been taught to most first-year students, but they (the skills and the students) are teachable*.

This observation, of course, does not come as news to anyone familiar with the "gospel according to Landis." I knew enough of the *gospel* to know that *Studying Engineering* was the only text to use for the course I was about to teach, but there's nothing like first-hand experience to bring home the reality of something you've only read about. Why should we assume that we have to teach freshmen the product rule for differentiation or Kirchhoff's law but somehow they are perfectly capable of learning by themselves to manage ridiculous time demands or form themselves into high performance teams? That's another terrible assumption. If we want our students to learn a complex procedure or master a complex skill, we need to provide them with some guidance.

Fortunately, all skills—including the ones we want our students to acquire—can be developed and improved through practice and feedback. If we want students to differentiate complex trigonometric functions, for example, we outline how it is done, give them examples, give them practice problems, correct and grade their efforts, give them more practice problems, and finally test them on their ability to solve similar problems. Not surprisingly, most of them end up knowing how to do it. If we did the same thing to facilitate the development of study, communication, teamwork, or time management skills, the result would be identical: most of the students would master those skills to an extent that most faculty members wouldn't imagine possible. Without structured training and practice, however, forget widespread mastery of high-level skills. What we'll get is instead what we've been getting and complaining about for years in that familiar faculty lounge grumbling about the lousy quality of today's students.

The following three sections discuss general pedagogical approaches for imparting new knowledge, new behaviors, and new attitudes.

<u>New Knowledge</u>

We're great at imparting new knowledge. That's what we do for a living. But we mainly do it by lecturing or by having students read a textbook. Those approaches are ok and will work in the context of an Introduction to Engineering course.

But we can be more effective in the "new knowledge" realm if we use multiple approaches, particularly those that involve active learning and student participation. The ancient adage contributed to Confucius:

.

> Tell me and I'll forget.
> Show me, and I may not remember.
> Involve me, and I'll understand

is a useful way to remember the importance of adopting "active learning" pedagogies. And you can have some fun with it. The following are descriptions of some of those you can try.

<u>Brainstorming</u>. Brainstorming is a technique for generating ideas in a group setting. Brainstorming is an excellent pedagogy for use in a "student success" course for at least three reasons: 1) it permits students to actively participate in coming up with strategies to enhance their success; 2) the ideas generated will be more useful and creative than any one person (student or teacher) could generate; and 3) students gain experience in a highly effective creative problem solving technique which they can put to use in other situations.

Brainstorming can be conducted individually (e.g. "Write down three things you want and need from students in this class."), in small groups (ideally 5-7), or by the whole class as a group. A problem can be posed by you or by someone in the class.

Group brainstorming can be conducted in two ways: 1) each member of the group offers one idea until all members have had a turn; or 2) any member having an idea speaks out whenever she wants (*freewheeling*). Every idea should be written down, ideally where everyone in the group can see them.

The basic ground rules for brainstorming are:

1. All ideas are welcome. There are no wrong answers. Wild ideas are encouraged.
2. During brainstorming, no judgment or criticism is allowed.
3. Generate as many ideas as possible. Seek quantity rather than quality of ideas. Don't give long explanations. Be brief.
4. Building on or expanding previous ideas ("hitchhiking") is encouraged.

Many of the exercises in *Studying Engineering* could be completed by brainstorming in class. For example, topics for brainstorming include:

- Tasks that an engineer might perform
- Benefits that will come to you when you graduate in engineering
- Things your professors can do for you in addition to providing instruction
- Skills or attributes you need in order to work effectively with other people

- Behaviors that would send signals to your professors that you don't think the subjects they are teaching are either interesting or important
- Types of documents an engineer might have to write
- Activities you can engage in over the next four years to improve your writing skills
- Positive things about your college or university

Lecture. What can I say? Long lectures are fun to give, but not fun to receive. When I was dean, one of my faculty proudly told me: "I spend eight hours preparing each of my ENGR 100 lectures." I was not popular when I responded: "Students don't need eight hours of your stuff crammed into one hour."

Here are some ideas on lecturing from the University of Minnesota (see: http://www1.umn.edu/ohr/teachlearn/tutorials/lectures/overview.html). Studies have shown students' ability to process lecture content falters after 15 minutes of sustained attention. Consequently, much literature and research on lectures in the past decade has focused on how to complement professors' delivery of content with exercises designed to motivate students' critical thinking–in short, on how to integrate elements of discussion pedagogy into lectures.

Good lecturers learn how to focus students' attention to help them identify and remember central points of the lecture. Considering rhetorical strategies such as context, audience, visual resources, and material demonstration (e.g., gestures, movement, tone of voice) in designing their lecture content and presentation, good lecturers organize lecture periods into smaller units and incorporate break-out activities to counter student passivity and foster critical thinking and problem solving. They provide materials such as study guides, sample test questions, lecture outlines or even lecture notes, slides, or overheads to complement their lecture.

Avoiding boring lectures is particularly important in an Introduction to Engineering course, which virtually demands "student-centered" pedagogies. If you do lecture, keep it short. Develop 15-minute modules on subjects like:

- Goal setting
- Time management
- Collaborative learning
- Test-taking strategies
- Stereotyping
- Benefits of graduate study
- Making effective use of your professors
- Personal assessment plans
- Astin's "student involvement" model
- What my education has done to enhance the quality of my life
- Participation in engineering student organizations

- The engineering design process
- The ABET process
- Student ethics
- How to get an engineering-related summer job
- Managing stress

You'll find that limiting your lectures on a subject to 15 minutes will be a fun challenge for you and something your students will appreciate.

Interactive Lecture. The interactive lecture involves alternating period of lecture (10-15 minutes) with periods of having students work in pairs or teams to answer a question, complete a discussion task, or solve a problem. A good source of activities for students following a short lecture is:

http://www.thiagi.com/interactive-lectures.html.

Example: Give a 15-minute lecture on one of the topics above and have students divide up into pairs or groups of three or four and address the following open-ended questions:

What are three things you learned from the lecture?
What are three things you can do differently using what you learned?
What are three benefits that will come to you from making these changes?

Self-directed learning. Here's a perspective on Self Directed Learning (SDL) from Mary Heather Hannah of the University of Arkansas (from Spring, 1998 issue of *Success 101*).

People learn about many things—sports, hobbies, careers, music, art, current events, and the like—outside of formal educational institutions. Often times a person will pursue a learning project with little or no formal planning. Allen Tough's 1979 book *The Adult's Learning Projects* lists several steps undertaken by successful self-directed learners. According to Tough self-directed learners will:

- identify specific knowledge and skills needed to complete the learning project
- decide on activities, materials, resources, and equipment needed to begin the learning project
- decide where to learn
- decide when to learn
- set the pace of learning
- set specific deadline or intermediate goals
- determine criteria for measuring progress
- secure needed resources and contact necessary resource people
- obtain money, as necessary
- create a learning environment
- detect personal learning obstacles and inefficiencies
- sustain motivation by confronting motivational blocks
- revise plans and goals, as necessary

Each person learns differently and, as such, will approach a self-directed learning (SDL) project differently. For example, I decide I want to learn about France. I could go to the library and find a book on France; I could obtain a language tape and learn to speak French; I could purchase a plane ticket and go to France. All of these learning plans could be implemented; however, the most appropriate plan depends on my goals and objectives.

In-Class Exercise: Planning a Self-directed Learning Project

This exercise allows students to practice planning a SDL project and to discuss differences among personal learning styles. Materials needed for this exercise include a large sheet of flip chart paper, colored markers, masking tape, and Tough's steps, for reference. The teacher must select a topic for the self-directed learning project appropriate for the average age of the students and their general interests. Possible topics may include identifying career opportunities for engineers or discriminating between several types of engineering.

The teacher will break the class into smaller groups of five or six and give each group a sheet of paper and a couple of markers. The paper and markers are used to record the learning plan. The students should be given the topic and approximately 30 minutes to develop a learning plan. After that time, the plans should be taped up so that everyone can see them. Students should then discuss the similarities and differences among the plans. Remember, there are no right and wrong answers, just different approaches to the same topic. However, some approaches may work better than others.

Planning. Definition of planning—"the process of setting goals, developing strategies, and outlining tasks and schedules to accomplish the goals." Teach students the principles of the planning process and then give them a chance to practice those principles. Whatever students can learn about the difference between "goals" and "objectives" and the difference between "strategies" and "tactics" will be of great value to them throughout their professional career.

Here are some examples of things your students can work on individually and/or in groups and in class or outside of class.

Develop a plan for making an 'A' on your next math exam
Develop a plan to improve your public speaking skills over the next four years
Develop a plan to become president of your engineering student organization
Develop a plan for getting an engineering-related job in industry next summer
Develop a plan to reach your ideal weight within one year
Develop a plan for an end-of-the term class picnic
Develop a plan for becoming a registered professional engineer
Develop a plan for returning to your high school to give a talk on "What is engineering?"
Develop a plan for becoming a NASA astronaut

<u>Student Presentations</u>. There's the old adage: "If you ever really want to learn a subject teach it." Making our students into teachers can ensure learning and give them a chance to practice and develop their oral communications skills. Lots of ideas here.

- At each class have one student (either pre-assigned or extemporaneously) give a 5-minute summary of what was covered in the previous class.
- Assign each student a different student service office on campus (student health center, financial aid office, intramural sports office, etc) and have the student prepare and deliver a two-minute presentation on what services are offered there.
- Assign each student an engineering discipline (electrical, mechanical, civil, computer, etc) and have them develop a presentation on some aspect of that discipline.
- Divide your class into groups and assign each the group the task of developing a presentation to high school students on "What is engineering?" and give that presentation at a local high school.

M.G. Prasad of Stevens Institute of Technology reports on his approach called "Brainsurfing—Extempore."

> "In order to make all the freshmen in my section (24 students) speak and participate in focused thinking and discussion, I required each student to speak extempore. I prepared a large number of single word topics on small paper slips and asked students to pick one for their extempore in the class. I call this exercise "brainsurfing" because the whole class had to focus on the topic in question.
>
> I gave the students the following list of topics to choose from:
>
> > *Education, Success, Money, Ecology, Spirituality, Engineering, Computer, Humanity, Culture, Values, Greed, Examination, Grades, Goals, Knowledge, Arts, Music, Languages, Happiness, Questions, Satisfaction, Respect, Curiosity, Religion, Science, Technology, Time, Nature, Plan, Limitations, Profession, Beauty, Friendship, Long-term, Short-term, Discipline.*
>
> During the presentations, students asked questions and made comments. If no questions came from other students, then I asked a question to trigger the discussion. Some examples of discussions were:
>
> <u>Greed:</u> The speaker began by writing on the board "Greed is bad." In response to this, many students argued that greed could be seen as a positive incentive for an entrepreneur. After some discussion, the speaker modified his statement on the board to "Greed is not good."

Grades: The student spoke about how grades could reflect performance on tests and not necessarily reflect the ability of the student in terms of understanding the material.

Discipline: The speaker on this topic described how reduction in class time in the college schedule (compared to high school) provides more freedom. This means that discipline to study has to be self-imposed.

Each topic generated a lot of interesting discussions and arguments. This brainsurfing extempore took almost two meetings. Everyone in the class spoke on one of the topics from the above list. I used to start my class with a puzzle (optical, mathematical, scientific, general, etc). Students seemed to like brainsurfing better as a way to start the class."

Projects. Lot's of scope here. Good opportunity to build community, teach teamwork, and promote learning.

Give students a project to design and build something that displays their name and bring it to class. After they've done it, ask them "Who did you make this for? Did you make it so the instructor can see your name from the front of the classroom? Did you make it so all students in the class can see your name?" Good way to start in on the idea of design specifications and help with the "community building" objective of the course at the same time.

Another idea is to divide your class into groups and have each group develop an idea for a project that will benefit the other students in the class. It might be to organize a party, raise money through a bake sale for a scholarship, make up a logo and print t-shirts, make up a digital on-line photo album of class activities, etc.

Engineering projects are not in the scope of this Instructor's Guide, but would provide excellent learning experiences for students. If you have ideas for projects that should be included in the final version of this *Guide*, please forward them to me.

Group Discussion/Dialog. Divide your students up into groups of 4-6 and give them a set of questions to stimulate discussion. Make sure each group has a facilitator to control tangents and a recorder to summarize what was learned. Set a norm that all group members must contribute. Have the reporter of each group report out at the end.

Many of the exercises at the end of the chapter in *Studying Engineering* would make suitable topics for discussion.

Examples of discussion topics:

Discuss the relationship between "success" and "happiness"

Discuss what is meant by the motto "No Deposit, No Return."

Discuss and compare the two viewpoints: 1) "People succeed because of their ability"; 2) "People succeed because of their effort."

Pick one of the "Greatest Engineering Achievements of the 20th Century" and discuss its impact on the quality of your life.

Discuss why you want to be an engineer.

Discuss the benefits of group study and collaborative learning.

Discuss today's reading assignment and what you learned from it.

Discuss the *Silver Rule* – "What you would not want others to do unto you, do not do unto them."

Assessment/Peer Assessment. Introduction to Engineering course is a great place to teach students about assessment of performance—both personal assessment; and assessment of others (peer assessment). Teach students a simple process for assessment—1.) three strong points and why; 2.) three areas for improvement and why; 3.) three insights that were gained from the assessment.

Examples of assessment assignments:

Assess today's group discussion

Assess this course to date

Assess your efforts to schedule your study time

Assess the academic advisement you have received thus far

Assess your last group study session

Assess Chapter 3 of *Studying Engineering*

Writing. Lots of opportunities to have students learn while improving their writing. They can write in their journal, write short critiques (1-2 page) about their experience and what they learned through class assignments, or they can do longer term papers.

Examples of topics for short papers/critiques:

Influences (teachers, parents, TV, etc) that led you to choose engineering as your major

Define "self-actualization"

Statement as to why you deserve a scholarship

Cover letter for your application for a summer job

Critique of what happened when you spent time preparing for each lecture over a two-week period

Short summary of a research project being conducted in your college

An excellent subject for a longer term paper would be:

Why I want to be an engineer.

Problem-based Learning. Problem based learning is a widely used inquiry technique that involves having students learn by solving real-world problems through a series of steps, while working in group. What is unique about problem-based learning is that the problem drives the learning. That is, before students **learn** some knowledge, they are given a problem. The problem is posed so that the students discover that they need to learn some new knowledge before they can solve the problem. Through problem-based learning, students learn how to use an iterative process of assessing what they know, identifying what they need to know, gathering information, and collaborating on the evaluation of hypotheses in light of the data they have collected. Research projects and engineering design projects fit well into problem-based learning.

The following are examples of projects that might fit well into an Introduction to Engineering course:

- Develop a plan for increasing the number of companies who conduct on-campus interviews for engineering graduates at the Career Planning and Placement Center
- Produce a 10-minute video on "Becoming a 'Master' Engineering Student"
- Develop a "Resume Book" for freshman engineering students seeking an engineering-related summer job and distribute it to local engineering employers
- Develop a proposal for how the engineering college could become involved in one of the engineering student design competitions listed in Chapter 5.
- Organize a monthly speaker program on "Emerging Opportunities in Engineering"

Reading. Students can learn a great deal from reading assignments, but only if they take them seriously. Although *Studying Engineering* doesn't lend itself well to multiple choice exams, there are four (Chapter 1 and 2; Chapters 3 and 4; Chapters 5 and 6; Chapters 7 and 8) in Appendix C that other instructors have found useful in motivating students to take the reading assignments seriously.

But it may take other strategies to ensure students do the reading assignments. Make it a requirement that prior to coming to class, students have completed the reading assignment, and developed at least three questions, issues, or perspectives they got from the reading and recorded them in their journal.

Spend some class time, processing the reading. Ask "How many of you did the assigned reading?" "How many of you formulated your three issues, questions, perspectives?" "Who would like to start?" Even this may not do the job. You may even have to find stronger incentives. For example, make attendance part of the grade and mark students "absent" who fail to come to class prepared.

Journaling. Requiring students to maintain a journal in the Introduction to Engineering is an excellent way to increase learning, give students the experience of maintaining a journal, and give you something for assessing student performance. Require that students purchase a spiral notebook that is used to document some or all of the following:

1. All notes taken in class
2. All completed course assignments
3. Questions, issues, or perspectives they gain from the reading and would like to raise in class
4. Their opinion of each section of the text

Collect the journals periodically and provide feedback. Make the journals some portion of the final grade.

Role Playing. One of the best ways of learning how to handle a situation is to **practice** with someone else. The purpose of such "role playing" can be to figure out exactly what to say—when meeting a special person, when interviewing for a job, when asking parents for permission to do something, when asking the boss for a raise. Or it can be to gain general social skills—how to initiate conversations at a party, how to tell interesting stories, how to terminate conversations, how to express opinions about social issues.

Examples of role playing:

One student plays a student who missed the midterm exam due to oversleeping and the other student plays the professor he or she is coming to see.

One student plays a senior who is interviewing for a job and the other student plays an industry recruiter.

One student plays a person asking and another student plays the student being asked to form a study group.

Informational Interviews. Conducting interviews can be a great learning experience for your students. Have them read the section on Informational Interviews on pages 230-232 of *Studying Engineering, 3rd Edition*. Discuss the various aspects of Informational Interviews in class. Give students the assignment of interviewing one of the following:

Engineering professor
Engineering executive
Recent engineering graduate
Senior engineering student

Have them either as homework or as an in-class group exercise make up a list of questions that will provide them some useful information and also "win over" the person they interview. Have them write a two-page critique—one page on what they learned from the other person; and one page on what they learned from the experience. Spend some time in class processing the outcome.

Story Telling. Telling stories is a great way to reach students and make a point. As an example, Cal State L.A. engineering students love to hear the story of how I was able to get $35 million to renovate our engineering facilities in spite of the fact that the person in charge of capital projects on our campus told me emphatically that it couldn't be done. I call it my "Don't take no for an answer" message, but the real message is that effective approaches can yield amazing results. You can read the story at:
http://www.discovery-press.com/discovery-press/newsletters/1999fall.asp.
Click on "A Personal Story Internal Locus of Control."

Other Learning Activity Types. Other learning activity types that you might draw on include:

Consulting
Case Studies
Internet Searches
Portfolio Building
Demonstration
Research

New Behaviors

Having knowledge about a behavior is not sufficient to bring about implementation of the behavior. Telling people how to run their lives is just not an effective pedagogy.

As an example. I could tell you should give up all animal protein (become a "vegan"), but I doubt you will do it. I could go further and also tell you all the reasons why. That wouldn't be likely to work either. I could even persuade you to read T. Colin Campbell's wonderful book *The China Study* that documents the studies that have shown the effect of high animal protein diets on all of the so-called "Western diseases" (heart disease, diabetes, cancer of all kinds, and many others). That might work, but is still unlikely. You have lots of reasons for eating what you eat, and getting you to change would take more than knowledge about the "whys" and "hows" of the new behavior.

Students, just like you and I, have lots of reasons for keeping on doing what they are doing. Getting them to change their behaviors will only occur if you use an effective pedagogy.

The following is a five-step pedagogy that will give you a very good chance of bringing about the behavioral changes you want.

Step 1

Establishing a Baseline. Survey students to assess whether or not they are currently practicing a particular success behavior to the extent desired. This can be as simple as asking for a show of hands ("How many of you regularly visit your professors during their office hours to seek advice or obtain one-on-one instruction?"), or through more sophisticated methods such as written surveys, personal interviews, etc.

Establishing a baseline serves several purposes. First, it puts the students on the alert that something is coming. You never did this before. Expecting something is coming can be a step in being receptive to it. Second, the baseline gives you information you didn't have before. You may suspect that students were on the wrong side of a particular behavior, but now you know for sure. And on the unlikely chance that you are wrong and that they are all on board already, you won't have to waste valuable time on it. Third, and perhaps most important, it's informative to the students—both in terms of seeing that they are not the "odd person out;" and also by showing them that there are others who are already practicing the behaviors.

Here are six pairs of questions to check out for starters:

How many of you would give yourself an A+ on the amount of time and energy you devote to your studies?	How many of you feel you need to increase the time and energy you devote to your studies?
How many of you schedule your study time so as to master the material presented in each class before the next class comes?	How many of you tend to wait until a test is announced and then try to cram for the test?
How many of you study on a regular basis with at least one other student?	How many of you spend virtually 100 percent of your study time studying alone?
How many of you regularly seek advice and one-on-one instruction from your professors during their office hours?	How many of you never go to see your professors during their office hours to seek advice or one-on-one instruction?
How many of you spend as much time on campus as possible and take advantage of the resources available to you here?	How many of you whiz onto campus to take classes and leave as soon as you can?
How many of you are actively involved in student organizations and seek to take on leadership roles in those organizations?	How many of you have no involvement with engineering student organizations?

Step 2

Delivering knowledge. Provide students with information and knowledge about why they should put the behavior into practice and how to best go about it. For example, continuing with the example of visiting a professor in their office hours, discuss human relations principles regarding how one can be effective in approaching someone in a higher position in an organization than them.

Delivering knowledge is what we are best at, so don't hold back. The knowledge can come from reading assignments, from lectures by you, from guest speakers, from videos, from assignments to interview others (upper-class students, faculty, alumni, industry representatives, etc.). Make liberal use of the various approaches for delivering knowledge outlined in the previous section on "New Knowledge."

Step 3

Building commitment. Work with students with the goal of gaining their willingness to try out the behavior. Start by having an in-class discussion on what the students think of the knowledge you have brought to them. An important part of building commitment involves working with students on their resistance to putting the behavior into practice (e.g., "Why don't you see your professors during their office hours?")

Don't cut corners on this step. Let your students talk it out. Ask various students who indicated that they don't practice the behavior to verbalize the reasons why they don't. Try and get other students to respond. In the end, seek their approval to try out the new behavior even just as an "experiment."

Step 4

Requiring implementation. Assign the students the task of putting the behavior into practice. (e.g., "Make up a list of questions you can ask one of your professors about herself and visit her during her office hours and ask those questions.")

Step 5

Processing the outcomes. Provide students with an opportunity to "process" what happened, both introspectively (e.g., "Write a one-page critique of what happened.") and/or through class discussions. During class discussion, try to get students talking to each other so they can learn from each other's experience.

EXAMPLE: EFFECTIVE USE OF ONE'S PEERS

Let's illustrate this pedagogy with an example. In our Introduction to Engineering class, we decide to determine whether our students are making effective use of their peers by engaging in group study and collaborative learning.

Step 1 - Establishing a baseline
Ask the class, "How many of you spend some fraction of your study time studying with at least one other student?"

Then ask the class, "How many of you spend virtually 100% of your study time studying by yourself?"

If your experience matches mine, you'll find that only a small fraction of freshman engineering students engage in group study with other students. If you verify this to be the case, then you can move to Step 2.

Step 2 - Delivering knowledge
Have students read articles on the efficacy of collaborative learning. Section 5.4 (pp. 188-196) of *Studying Engineering, 3rd Edition* would suffice for this purpose. The section there presents the idea that there are only two learning structures: 1) solitary; and 2) collaborative (i.e., either you do it alone, or you do it with someone else), and that collaborative learning has three distinct advantages over solitary study:

1. You'll be better prepared for the engineering "work world"
2. You'll learn more
3. You'll enjoy studying more and therefore do more of it

Give the class your perspective on the value of collaborative learning. Discuss how to go about it including some of the pitfalls to watch out for. Bring in an upper-class student or recent graduate who studied with other students to give his or her perspectives.

Step 3 - Building commitment
Ask the class what they think of the knowledge you have brought to them. Ask those who indicate they study alone, "Why don't you study with other students?" Have those students who indicated they engage in group study relate why these reasons have not kept them from doing so. Seek agreement from those who are studying 100% alone that they will try out studying with other students, if only as an experiment.

Step 4 - Requiring implementation
Give the class the following assignment:

Identify a study partner in one of your key classes.

Within the next two weeks, get together with that person for at least a two-hour study session.

Write a one-page critique of what happened.

Come to class two weeks from today prepared to share what happened with others in the class.

Step 5 - Processing the outcomes

At the designated class, lead a discussion about what happened. Have several students read their one-page critiques aloud. Ask other students to tell what happened during their collaborative learning session. Seek to find out not only what worked, but also what didn't work. Try to get a discussion going among students rather than just from each student to you. Refrain from giving your views on each comment. Turn issues that come up back to the class (e.g., "Does anyone have an idea about that one?")

Collect the one-page critiques and review them. If appropriate, discuss what was learned from them at the next class. If it seems that additional knowledge has been brought forth and the level of resistance has been reduced during Step 5, you may want to return to Step 4 (i.e., assign the class to repeat the assignment).

Through the pedagogy discussed in this section, you can bring about significant changes in the attitudes and behaviors of your students. At the end of your *Introduction to Engineering* course, you can check it out. Ask the class questions such as:

> *How many of you have devoted considerably more time and effort to your studies this term than in previous terms because of what we have done in this class?*
>
> *How many of you used to cram for tests and are now scheduling your study time and adopting the principle that you master the material presented in each class session before the next class session?*
>
> *How many of you used to do all of your studying alone and are now studying with other students on a regular basis and that's working for you?*
>
> *How many of you never went to see your professors outside of class and are now receiving one-on-one instruction from your professors on a regular basis and that's working for you?*
>
> *How many of you used to come to campus only to attend your classes and are now spending more time on campus and using the resources available to you?*
>
> *How many of you had no involvement with engineering student organizations and are now actively participating?*

When all the hands go up as you ask these questions, I guarantee you will feel good about the fact that you have made a significant difference in the lives of your students and in their success.

New Attitudes

We have attitudes about everything. I could name something (e.g., money, religion, family, friends, professors, tutoring, the war in Iraq, redevelopment, tattoos, football, antiques, jogging, marriage) and almost everyone would have an attitude about it. Many of these attitudes were "installed" at a very early age by those we looked to for our very survival. They were not necessarily installed intentionally, but they operate in powerful ways.

The importance of attitude in achieving success has been expressed from the earliest times as indicated by the following quotes from the classics:

"They can because they think they can." - Virgil

"Our doubts are traitors, and make us lose the good we oft might win, by fearing to attempt." - William Shakespeare

"The mind is its own place, and in itself can make a heav'n of hell, a hell of heav'n" - John Milton

Given these perspectives on attitude, it is not surprising that a recent excellent work by Besterfield-Sacre and others at the University of Pittsburgh indicated that the attitudes engineering freshmen bring with them have a significant impact on their success in engineering study. Through this work, the *Pittsburgh Freshman Engineering Survey* was developed and used to measure the attitudes of engineering freshmen in thirteen categories listed below. The study showed that attitudes of engineering students correlated well with student persistence in engineering, therefore providing a tool to identify "high risk" students.

Student Attitude	Definition
General Impressions of Engineering	How much a student likes engineering
Financial Influences for Studying Engineering	Belief that engineers are paid well and that having an engineering degree helps assure career security
Perception of the Work Engineers Do and the Engineering Profession	Considers engineering a respectable field and the work engineers do has a positive impact in solving the world's problems
Enjoyment of Math and Science Courses	Preference for math and science courses over liberal arts courses
Engineering Perceived as Being a "Precise" Science	Belief that engineering is an exact science

Engineering comparing Positively to Other Fields of Study	Preference for engineering over other fields of study
Family Influences to Studying Engineering	Belief that parents are influencing student to study engineering
Confidence in Chemistry	Self-assessed confidence in chemistry knowledge
Confidence in Communication Skills	Self-assessed confidence in writing and speaking skills
Confidence in Basic Engineering Knowledge and Skills	Self-assessed confidence in knowledge of calculus and physics, and in computer skills
Adequate Study Habits	Beliefs about the adequacy of current study habits
Working in Groups	Preference for working in groups
Confidence in Engineering Skills	Belief that one has the creative thinking, problem solving and design skills required to survive in engineering

While we would all tend to accept the familiar cliché

Positive attitudes produce positive results;
Negative attitudes produce negative results

we would probably differ in our view as to whether it is our role as engineering educators to work with our students to change their attitudes and whether we are or can be effective in this role. Your view on this issue is probably not "black or white." It is likely that you are willing and are, in fact, already working to impact student attitudes in some areas, but may be reluctant to take on attitudes in other areas.

First, let's identify some of those attitudes that impede students' success. The establishment of a goal (e.g., B.S. degree in engineering) provides a criterion, which can be used to judge attitudes as either negative or positive. Negative attitudes are defined as those that lead to non-productive behaviors, i.e., behaviors that tend to interfere with students' academic success. Positive attitudes are defined as those that lead to productive behaviors, i.e., behaviors that support students' academic success.

Among those negative attitudes that can inhibit the academic performance of first year engineering students are:

- Weak commitment to goal of graduating in engineering
- Unrealistic view of what's expected (e.g., overconfidence, naiveté)
- Low self-confidence
- Lack of self-worth (i.e., tendency to sabotage their success)

- External "locus-of-control" (i.e., adoption of victim role)
- Unwillingness to seek help
- Resistance to change (e.g., personal growth and development)
- Tendency toward procrastination (e.g., negative view toward time management)
- Avoidance of areas of weakness or perceived unpleasantness (e.g., written communication, interpersonal interaction, chemistry)
- Reluctance to work with other students (i.e., avoidance of group study)
- Negative view toward authority figures (e.g., parents, professors)

How is it that bright, academically prepared first-year engineering students could hold a series of negative attitudes that threaten their academic success, and not do anything about the situation? One would think that such students as logical thinkers and analytical problem solvers would identify the "problem" and solve it. The reasons so many students don't provides the direction we, as engineering educators, need to be more effective at helping them.

Students' values and attitudes, instilled in them throughout their childhood, are deep and often not rational. Furthermore, students may not be consciously aware that they hold certain attitudes. Even when they are aware of a negative attitude, they may not believe they can change it. How often have you heard someone say: "Well, that's just the way I am."? Or they may not want to change, not realizing the consequence of holding the negative attitude. (e.g., "I like being disorganized.")

An excellent reference on the impact of one's attitudes on their success is Deekpak Chopra's book *The Seven Spiritual Laws of Success*. Students would benefit from reading this book, particularly if assisted in processing and internalizing the concepts.

Chopra's "Law of Karma" explains the importance of becoming "conscious,"

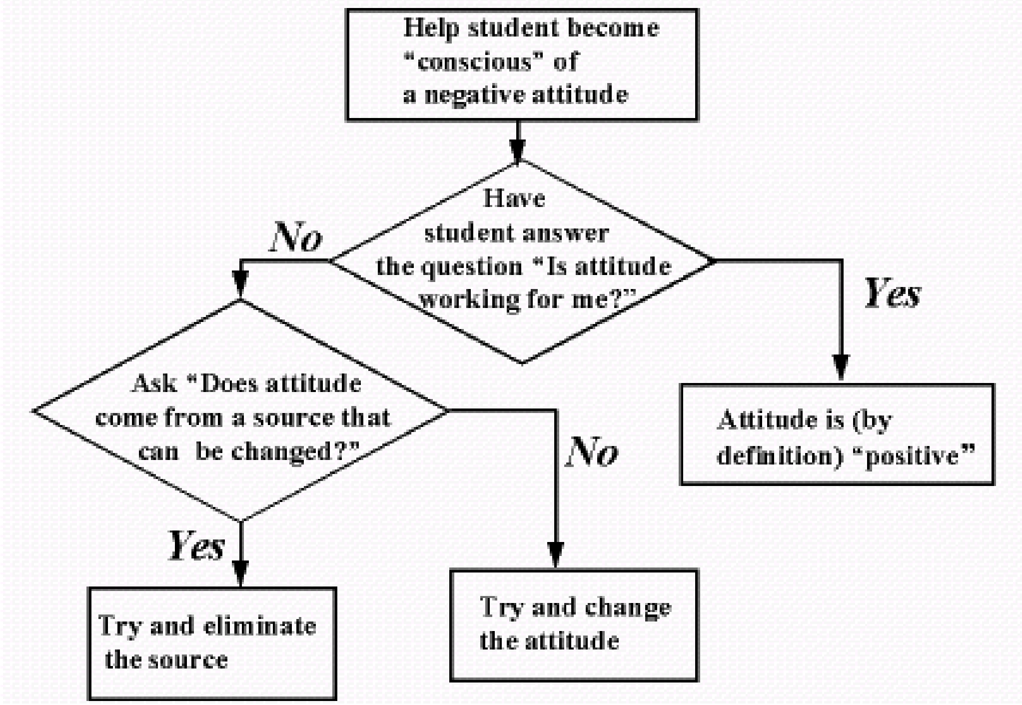
> *Most of us, as a result of conditioning, have repetitious and predictable responses to the stimuli in our environment. Our reactions seem to be automatically triggered by people and circumstances, and we forget that these are still choices that we are making in every moment of our existence. We are simply making these choices unconsciously.*

and how through doing so, we are able to change our choices:

> *If you step back for a moment and witness the choices you are making as you make those choices, then in just this act of witnessing, you take the whole process from the unconscious realm into the conscious realm. This procedure of conscious choice-making is very empowering.*

The following figure provides a methodology for helping students change negative attitudes to positive ones.

Methodology for Changing Negative Attitudes to Positive Ones



The steps in this methodology are as follows:

1. Identify key areas in which engineering students' attitudes will have a significant impact on their academic success
2. Assist students in becoming "conscious" of the attitudes (both negative and positive) they hold in these areas.
3. For each attitude have students answer the question: "Is this attitude working for me (positive attitude) or against me (negative attitude)?"
4. For each negative attitude, have students answer the question: "Why do I hold this attitude?" (i.e., What is its source?)
5. Have students answer the question: "Can I change an attitude that is not working for me (negative attitude) to one that will work for me (positive attitude)?"

Since the time available in an Introduction to Engineering course is not adequate to work with every student on each of his or her negative attitudes, the objective should be to provide students with "self-modification" skills such that they have the ability to negotiate the five steps above on their own. The efficacy of such self-modification skills is documented in the psychology literature for those interested in more depth on this subject.

The following describes a practical approach for implementing the above five steps in an Introduction to Engineering course.

Step 1. Conduct an exercise during class in which you ask students to identify key areas about which their attitudes (positive or negative) are likely to have an impact on their academic success. During this brainstorming session, write all responses on the blackboard. Feel free to add a few of your own.

Step 2. Pick 8-10 of the areas listed, and as a homework assignment have each student write down three positive attitudes and three negative attitudes they have about each area.

Step 3. During the class period in which the homework assignment is due, have volunteers share negative attitudes they have about each of the areas. Ask each respondent to answer the question: "Is this attitude working for me or against me?" Note that you may find in some cases what students perceive as a negative attitude may in fact be working for them (e.g., a negative attitude toward the inertia of the university bureaucracy may have taught the student to be more effective in how he or she approaches dealing with it).

Step 4. For each attitude that is not working for a student, ask him or her: "Do you know why you hold this attitude? Where did it come from?" In some cases, the attitude may have a legitimate source. For example, a student that is taking 16 units and working 40 hours a week may have a very legitimate reason for resenting the amount of homework he or she is required to do. In such a case, the possibility of eliminating the source of the negative attitude can and should be explored.

The primary purpose of asking students to identify the source of negative attitudes is to emphasize that in most cases negative attitudes were learned and hence can be unlearned. Another way to illustrate to students that attitudes are not absolute is to have several students in the class describe their attitude about a specific issue (e.g., "What is your attitude about this class and what we are doing here today?"). Seeing that their peers have much more positive attitudes can have a strong impact on a student's negative thinking.

Step 5. For each attitude that is not working for a student, ask him or her: "Can you change the attitude to one that will work for you?" Teach the students that one of the best techniques for changing a negative attitude to a positive one is to find a higher context for their thinking. For engineering students, the most appropriate higher context is their goal of success in graduating in engineering.

For example, let's imagine that a student relates that she is failing math because the professor is boring, unprepared, never smiles, and doesn't like her. This student has developed the belief that: "I can't pass a course if I don't like the professor." The student has adopted an external locus-of-control in which passing her math course is viewed as totally in the control of the professor. It is important that she become "conscious" that this is a negative attitude (one that interferes with her goal of success in school), and further that she come to realize that the attitude can be changed. Suggestions from the class might lead her to change her attitude to: "I can pass a class when I don't like the professor, but it is going to require me to adopt alternate strategies and to put in more work." This positive attitude might lead to behaviors that include sitting in on another instructor's lectures, getting old exams, or seeking help from students who passed the course last semester.

Strategies for Accomplishing Each of the Objectives

Objective 1A. Socialization

Your students are each other's most valuable resource. Building students in an Introduction to Engineering course into a learning community will benefit them more than perhaps any other thing you can do. When students are part of a cohesive group, they have the opportunity to support each other academically, socially, and psychologically. As a community of learners, they can advance their individual and common goals by creating a social environment where studying, heavy workloads, and cooperation are the common ground.

The first step in building a learning community is helping students get to know one another by name. Set as a goal that each student in your class can call the first and last name of every other student in the class without hesitation. This can be accomplished by devoting a few minutes in each class period to "The Name Game."

Form students randomly into groups of six or seven. In their groups, the first student introduces himself or herself (first and last name); the second student introduces the first student and then himself or herself, the third student introduces the first two students and then himself or herself. Continue until each student can introduce all students in the group (generally takes about five minutes).

Mix groups each class period. Repeat exercise until every student in the class can introduce every other student (generally five or six class periods for a class of 30). You should sit in on the groups during the exercise. In this way, you can learn the names of the students in your class.

Other attributes can be added such as major, hometown, favorite hobby, etc. For example, first student gives name, major, hometown, and favorite hobby. Second student gives all of the attributes of the first student and then his or hers. And so forth.

The five-step pedagogy for working with students to change their behaviors on the next page provides an excellent approach for getting students to "buy-in" to "The Name Game."

Other attributes can be added such as major, hometown, favorite hobby, etc. For example, first student gives name, major, hometown, and favorite hobby. Second student gives all of the attributes of the first student and then his or hers. And so forth.

The Name Game: It's All in How You Do It

Let's say you've read this and you're convinced. With great enthusiasm, you go to your next class meeting and announce to your students: "I've just read an article that convinced me that we should learn each others' names, and we're going to spend a few minutes each period doing a name learning exercise." How do you think your students would react?

The following is a "sure fire" way to get "The Name Game" to work.

<u>Step 1 - Establish a baseline</u>

Go to class and ask your students: "How many of you could name all of the students in this class? How many of you could name half of the students in the class? How many of you could name the student sitting on your right and the student sitting on your left?" If you get any "takers," have them try it.

<u>Step 2 - Deliver Knowledge</u>

If your experience matches mine and you find that your students do not know each other, explain the benefits of being part of a learning community. Have the students do a brainstorming exercise to identify a list of ways they could benefit from knowing each other. Or give them the assignment to read Section 5.4 Making Effective Use of Your Peers in *Studying Engineering, 3rd Edition* (pages 188-196).

<u>Step 3 - Build Commitment</u>

Seek your students' opinions on whether the benefits of being part of a learning community would be of value to them. Ask them whether they would like to know each other. Try to get them to agree to learn each other's names, even if just to see what it's like to be in a class where everyone knows each other.

<u>Step 4 - Implementation</u>

Conduct "The Name Game" as described above.

<u>Step 5 - Process outcomes</u>

Near the end of the term, ask the students to write a one-page critique describing any differences they experienced by knowing all the students in the class. On the day the assignment is due, ask several students to read their critiques aloud. Ask other students to comment and give their views.

Engineering faculty who have conducted this exercise have reported significant changes including improved attendance, increased energy level, more attention to homework, and more in-class questions. Learning communities work. ***But it's not only what you do; it's how you do it.***

Keep the name game going until you have accomplished your objective (every student in the class can call the first and last name of every other student without hesitation). Don't <u>assume</u> that it's done. Check it out. I've often run into instructors of Intro to Engr courses that believed their students knew each other because they had each student introduce themselves and they had students work in groups on projects. Those activities can help, but they won't do the job. Actually, you'll know when your students know each other, because you'll have trouble quieting them down and getting their attention away from each other when you want to start the class.

Objective 1B. Group Building

The purpose of the "group building" stage is to create a strong sense of group cohesiveness and an attitude of mutual support. Building this sense of group is not as straightforward as getting students to know each other. But this process of shifting students' perspective from being "individual-centered" to being "group-centered"—from a spirit of competition to a spirit of cooperation and mutual support—is extremely important. Not only will this shift enhance students' effectiveness as engineering students but also it will enhance their effectiveness throughout their lives and their careers.

Discuss with your students the idea that people are more effective working in groups than as separate individuals. Point out to them that they are each other's most valuable resource. Discuss the idea that if they agree to define themselves as a supportive group, the payoff will be that each of them will be in a highly supportive environment—the type of environment that will promote their individual success.

There are a variety of ways to build a group identify—an *esprit de corps*, if you will. Take a group digital photo and e-mail it to each student in the class. This reinforces the group identify and can be helpful to you and them in learning names. Have the students select a name for the group. Develop the class into an organization, much like a student organization, with committees and subcommittees organized around specific purposes (e.g., arranging speakers, organizing a volleyball game, putting on an end-of-the-term party, making a class T-shirt). Encourage the group to take on an academic challenge goal (e.g., "Last year the students in my Introduction to Engineering class achieved an average fall term GPA of 2.55. Are you willing to set a goal of beating that?")

Develop an address, telephone, and e-mail list for all who are willing to share that information. Encourage students to communicate with each other outside of the class. Where some of the students are in common sections of other classes, encourage them to get together for group study sessions. Suggest that they do things with other members of the group such as attending an engineering student organization meeting or going to a sporting event or cultural event on campus. In subgroups, have them conduct a scavenger hunt to learn about campus resources.

This is just a partial list of those things you can do to build the students in your Introduction to Engineering course into a supportive group. Enlist the students in thinking up ideas. Between you and them, you can come up with many more ideas. If you try it, it'll work, the students will benefit, and both you and they will have fun in the process.

Objective 1C. Human Relations Training

The need for human relations training comes about because even if students are committed to supporting each other, many lack the skills to be effective in doing so.

You can either do the training yourself or seek help from professionals in the field. Generally, very experienced and highly effective human relations trainers can be found on your campus—in the counseling center or in the psychology or educational psychology departments.

Exercise

One simple but powerful class exercise is to have each student write down two lists:

1. A list of things they want and need from other students in the class.
2. Another list of things they don't want and don't need from other students in the class.

A compilation of all the students' lists will provide an excellent basis for discussing those behaviors that are supportive of others and those behaviors that are not supportive of others.

For example, one item on the list of "don't wants" might be "I don't want to be put down by others in the group." Discuss the concept of put-downs. Ask the class "How many of you like to be put down by someone even if it is done in jest?" Then ask the class "How many of you have felt put down at one time or another by students in this class?"

You are likely to find that no one likes being put down but many have felt put down. Ask the class "What can we do about this problem, i.e., no one wants it; everyone has it?" Once when I did this, a young lady raised her hand and said "When I feel put down by someone, I tell him or her 'I love you too!'" The class agreed that anyone who felt put down by another in the class would use this way of telling them so. We checked back several times over the next few weeks and found that this had solved the problem of put downs in the group.

Other common "don't wants" and "don't needs" include:

Don't want to be discounted
Don't want people to break agreements they make with me
Don't want information to be withheld from me

Each of these unsupportive behaviors can be worked on with the group and reduced if not completely eliminated.

Objective 2A. Motivation

Helping students understand that getting a good education (and specifically an engineering education) will significantly enhance the quality of their life throughout their entire life is an effective way to strengthen commitment. Tell them what your education has meant to your life. When you have other speakers (dean, department chairs, industry representatives), ask them to spend some time giving their own personal testimonials.

Conduct a brainstorming exercise with your students in which they list all of the rewards and opportunities that will come through success in engineering study. Except for the idea that engineers are well paid, many students have given little or no thought of the many other rewards an engineering education will bring to them. Students should be able to come up with a list of thirty or four items. Note: This would perhaps best be done before they read Section 2.5, pages 48-61 of *Studying Engineering, 3rd Edition*. The list there (i.e., Ray's Top Ten List) was developed through such brainstorming exercises with students. That list is:

1. Job satisfaction
2. Variety of career opportunities
3. Challenging work
4. Intellectual development
5. Opportunity to benefit society
6. Financial security
7. Prestige
8. Professional work environment
9. Understand how things work
10. Avenues for expressing your creativity

Spend significant class time discussing each of the items on the students' list. What is it? Why would one value it? For example. What do we mean by prestige? Is engineering a prestigious profession? What benefits are there to choosing a prestigious profession?

Perhaps the most powerful thing you can do to accomplish this objective is to give students the assignment of writing a 500-750 word term paper on the topic of "Why I Want to Be an Engineer" by picking their top five items on the list and personalizing their reasons for valuing each item they selected.

Objective 2B. Understanding the essence of engineering

Giving an articulate response to the question: "What is engineering?" is no easy task. Just pose the question to one of your faculty colleagues or to a professional engineer. You'll probably get a lot of "hemming and hawing." So what makes you think your students can give a good response to that question? Check it out. Have students extemporaneously explain what engineering is in your class. Most engineering students are asked by friends and relatives about engineering. It's not healthy for our students to be embarrassed when they are asked to explain what their chosen profession is.

As an assignment, have students develop a short, but articulate response to the question "What is engineering?" Have them memorize it and practice it, and then have them do it in class.

Zahir Khan at Mt San Antonio College has created a "win-win" project to both help students learn about engineering and recruit high school students into his program. The following is the project as he assigns it.

Presentation Assignment

During this course you will be exposed to ideas regarding engineering as a profession, student success, and course advisement from your professor as well as guest speakers. You should take good notes to enable you to make a PowerPoint presentation to a high school of your group's choice. You will be in a group of four or five students. The presentation will be evaluated by the high school teacher. This evaluation will be due by the end of the 6^{th} week of the course.

Your sources for your presentation can be from:

1. Guest speakers
2. Your professor
3. The textbook
4. Contacts with other engineers
5. Internet
6. Handouts

Use as many topics from below and any additional one you can think of:

1. What is engineering?
2. Ray's top ten reasons for choosing engineering.
3. The importance of taking the correct course sequence in high school and college in order to complete your degree in a timely fashion.
4. Why Mt. San Antonio College should be their first choice.
5. The advantage of taking math placement test at Mt. San Antonio College as soon as they complete their last math course in high school.
6. Major engineering fields such as civil, mechanical, industrial, and electrical/computer engineering.

The importance of keeping the presentation interesting and smooth cannot be over emphasized. Additionally, encourage students to ask questions as they arise. This will keep them involved. Remember that 10-20 percent of your course grade depends on this presentation. Upon completion of your presentation, take the completed evaluation sheet from the teacher, and turn it in to me. This short term course ends in eight weeks. Students not participating in the presentation and its preparation will receive no credit toward this grade.

Objective 2C. Global awareness of engineering

Good place for guest speakers. To help students learn about the academic disciplines, have representatives of several (or all) departments (either the chair or the best faculty member) talk about their discipline. It may be more efficient to have a panel of these representatives in which each gives a short (10 minute) presentation followed by a question and answer period. Alternatively have teams of students work on researching the Internet and putting together a presentation on each discipline and make the presentation to the class.

To make students aware of engineering job functions, have one or more industry representatives as guest speakers to talk about design, development, test, management, etc.

Have students write a short paper describing one of the engineering disciplines or one of the engineering job functions.

Objective 2D. Industry practice

One way to strengthen students' commitment to engineering is to expose them to the North American Industrial Classification System (NAICS 2002) code of the Federal Government available on the Census Bureau web site:

http://www.census.gov/epcd/www/naics.html

Under NAICS, there are 30, two-digit NAICS codes (in the range from 01 to 99) each indicating a broad industry sector. For example, Industry Sector 33 is "Manufacturing." Within Industry Sector 33, there are eight major industry groups, each having a three-digit NAICS code. For example, Major Industry Group No. 334 is "Computer and Electronic Product Manufacturing." And within Major Industry Group No. 334, there are six industry groups, each having a four-digit NAICS code. For example, Industry Group No. 3345 is “Navigational, Measuring, Electromedical, and Control Instruments Manufacturing.” And within Industry Group No. 3345, there are ten industries. For example, Industry No. 334510 is “Electromedical and Electrotherapeutic Apparatus Manufacturing.” And within Industry No. 334510, there is a list of 53 apparatuses, each representing a collection of companies that make that product, most of which use engineers.

One way to bring the vast range of opportunities to the attention of students is to have them choose one such product (e.g., lithotripters) and research what companies are involved in the manufacture of this product and how they use engineers in their organization. Quickly accessing such a product is now facilitated since the NAICS code can be easily accessed, and once a product is chosen an Internet search can be used to identify the companies that make it. And "Informational Interviews" (see page 283-285 of *Studying Engineering, 3rd Edition*) can be put to good use in completing this exercise.

Firsthand knowledge of how much activity there is in just one of literally tens of thousands of product areas can be very motivational to students. And they may very well develop an interest in an area and contacts in a company that could lead them to a future employment opportunity.

An alternate approach for giving students a feel for the vast industry structure would be to have them go to a web site like: http://biz.yahoo.com/ic/ind_index.html, which provides information about the stock market relative to various industry sectors. Industry sectors listed there are:

Basic Materials
Conglomerates
Consumer Goods
Financial
Healthcare
Industrial Goods
Services
Technology
Utilities

A large number of industry centers are listed for each of these industry sectors providing easy access to information about the various companies in each of the centers.

Objective 2E. Professional student organizations

Active participation in engineering student organizations can contribute to building students' commitment to engineering study. In fact, engineering student organizations are an effective vehicle for students to accomplish for themselves much of what you are trying to accomplish in your *Introduction to Engineering* course.

Typically, engineering student organizations provide benefits to their members in five areas:

Social interaction
Professional development
Academic development
Personal development
Service to the college and the community

Note, in fact, that this list is virtually identical to the five key themes of your Introduction to Engineering course.

Discuss these benefits with your students. What could be better than having your students interact socially with other engineering students rather than with students from other majors or friends from high school? Through participation, students will gain a sense of community and of belonging that can be highly motivational.

Tell your students about the important skills they will develop through participation in engineering student organizations. Emphasize that the leadership, organizational, and interpersonal skills they will gain will be extremely important to their success as an engineering professional. And let them know that the professional development activities of an engineering student organization such as speakers, field trips to industry, and career day programs will complement what they are getting from your *Introduction to Engineering course*.

Make it easy for your students to join these organizations. Provide them with information about how to join and about upcoming meetings. You could even assign them the task of attending a meeting and writing a critique of what happened there. Invite leaders of these organizations to speak to the class to inform them about the activities of their organization. Make sure they emphasize why they got involved and what they get out of that involvement.

Objective 2F. Ethics and professionalism

Here's what Jim Thomas at Lamar University does for this one.

> "I talk about engineering ethics quite extensively and supplement the text with handout materials (Code of Ethics for Engineers: The Fundamental Principles and The Fundamental Canons). We also show either "Gilbane

Gold" or "The Incident at Morales" video and then follow up with a discussion period. I give a homework assignment for them to go to the National Institute for Engineering Ethics website at Texas Tech and go to the "Applied Ethics Case of the Month" and discuss proposed solutions to the ethical situation presented." ["Gilbane Gold" and "The Incident at Morales" videos and the "Applied Ethics Case of the Month: can be accessed at: http://www.murdough.ttu.edu/pd.cfm?pt=AECM]

Objective 3A. Time on task

This is a big one! All studies of student success have it #1. If students are not working to full potential, the first place to look is at how much time they are devoting to studying. Perhaps the most effective strategy is to have students keep a record of how much they study over a one-week (or even two-week) period. This represents a significant new "knowledge." It is very common for students to have an inflated impression of how much they are actually studying. By keeping track, they get a "reality check" that can be very enlightening. This also represents the "Establishing a Baseline" step in the Five-Step Pedagogy for changing behaviors.

Next comes the knowledge step. Have them read Section 5.2 "Organizing Your Learning Process" (pages 174-186) in *Studying Engineering, 3rd Edition*. Give them your views on how much time they should study and the importance of keeping up in their classes. Lead a class discussion on what they learned from these sections. This is perhaps the most important stuff you'll deal with. The ideas are simple, but powerful. Just the idea of scheduling your study time and making the same commitment to that time as you make to class time are ideas your students are unlikely to have thought about in such explicit terms. Another simple but powerful idea—that by studying from test to test rather than from class to class they are converting a sound educational process into an unsound one—can't be explored too much. Take as much time as you need to make sure students understand all of the various ideas presented in Sections 5.2. Rather than explaining the concepts to them, have them explain the concepts to you.

Once you feel the students have the knowledge, then move to Step 3 of the pedagogy. Ask the class "What do you think?" Are you willing to try out these ideas to see how they work for you?

Then, give students the following assignment:

Determine how many hours you believe you need to study in each of your classes to master the material presented in one session of the class

For the next two weeks, make up a weekly schedule that includes putting in that amount of study time and doing it as soon as possible after the class but definitely before the next class comes

Stick to the schedule.

Write a one-page critique on what happened and come to class two weeks from today prepared to discuss your experience

Two-weeks later lead a discussion of what happened. I expect you'll find a lot of "believers." This stuff really works and once students have experienced it, many will adopt it habitually.

Objective 3B. Interaction with peers

An effective strategy for "turning on" students to collaborative learning and group study is to give them a chance to experience it.

Pick a logic problem from one of the crossword puzzle books available at any newsstand (You know, the ones that give clues like "Ms. Smith is not the baker."). Divide your class in half. Have one half of the class divide into groups of four or five and work on the problem for forty-five minutes as a group. Assign each student in the other half of the class the task of solving the problem by working alone.

You're likely to find that the students working alone get restless after ten minutes; whereas when you call time after forty-five minutes, the students working in groups ask for more time. At the next class meeting ask students whether they continued working on the problem since the exercise. Have a class discussion that uncovers the differences between those who worked in groups and those who worked alone.

Nick Arnold at Santa Barbara City College uses the "Pirate Treasure Puzzle" as follows:

> A pirate ship captures a treasure of 1000 golden coins. The treasure has to be split among the 5 pirates: 1, 2, 3, 4, and 5 in order of rank. The pirates have the following important characteristics:
>
> Infinitely smart.
>
> Bloodthirsty.
>
> Greedy.
>
> Starting with pirate 5 they can make a proposal how to split up the treasure. This proposal can either be accepted or the pirate is thrown overboard. A proposal is accepted if and only if a majority of the pirates agrees on it.
>
> **The Question**: What proposal should pirate 5 make**?**

In Nick's own words:

"I split the class in half, with one half in groups of 5, and the other half as individuals, and give them about 15-20 minutes. Of course, the groups have a fun time, and the individuals are miserable. One semester I tried giving them the hints towards the solution, but that actually ruined the process (a large part of the collaborative group work was trying to figure out what the problem is even asking –

with the hints, groups and individuals focused in on their "solution" too easily). Therefore, I just give them the puzzle with no hints."

Note: Solution can be found at: http://puzzle.dse.nl/teasers/pirate_treasure_us.html

Another approach to getting students to change from solitary study to group study is to use the Five-Step pedagogy. The specific steps for this have already been outlined in the section on "New Behaviors" on page 21-22 of this *Instructor's Guide.*

Objective 3C. Interaction with faculty

The five-step pedagogy for changing students' behaviors also works very well with this objective. Find out how many of the students in your class are visiting their professors during their office hours to get advice and one-on-one instruction.

Assuming that many are not, have them read the Section 4.4 in *Studying Engineering, 3rd Edition* on "Making Effective Use of Your Professors" (pp. 151-160). Give them your views on the subject. You can even read the Dale Carnegie anecdote on page 155 aloud in class. Have the students brainstorm examples of where they could apply the lessons of that story.

Don't forget Step 3 of the pedagogy. Lead a discussion in class of what your students think of the new knowledge they have been given and whether they are willing to try to develop a relationship with one of their professors. Have students develop a list (four or five) of questions they could ask their professor during his or her office hours. This can be done in class in small groups or as a homework assignment.

Then give the students the assignment of visiting their professor during his/her office hour and asking the questions. Have the students write a one-page critique on what happened. Spend some class time processing the results. After this exercise, you might find students asking you: "Where did you go to college?" When they do, just tell them: "You're not allowed to use my stuff on me!"

Objective 3D. Campus resources

An often-used approach for informing students about various campus resources (career center, student health center, learning center, library) is to have representatives of those "student service" organizations speak at your Introduction to Engineering class.

Perhaps a better approach for having students learn about these resources while having fun and building community at the same time is a "Scavenger Hunt." Here's one example from far away, which hopefully will give you ideas for yours.

Jeff Jawitz, Educational Development Officer in the College of Engineering at the University of Cape Town (UCT) in South Africa, conducts a scavenger hunt in his *Introduction to Studying Engineering* course to help students discover some of the sources of information available to them. He divides his class into groups and sends each group off for 45 minutes to learn things like the following:

What should you do if you lose your UCT Registration Card?

How much does it cost to share a double room in Kopano Residence and eat two meals a day (breakfast and dinner)?

What is the date of your first mathematics class test?

Until what date can a student withdraw from a whole course in the curriculum?

What is the name of the head of your Department?

How many copies of *A Handbook of Writing for Engineers* by Joan van Emden are there in the library?

How much does a current year UCT Student Diary cost?

Photocopy the front page of a math examination paper (Math 103 or Math 105) from any year and hand it in with the answers to the above questions.

There are several versions of this list. A small prize is awarded for the group that has performed the tasks and answered the most questions correctly.

Objective 3E. Time on campus

Again, the Five-Step Pedagogy will work well for this one. Find out how many students come to campus early in the day and do their work there versus how many just come to take classes and leave as soon as possible. This will vary greatly with the type of campus (commuter vs. residential) and type of student (traditional full-time vs. working, part-time). The context may differ as well. Students who live on campus may view being in their residence hall as being "on campus" when, in fact, the distractions there may be as great or even greater than those "at home" for a commuting student.

You can give a powerful perspective on this one, one that students may not have thought about explicitly. The perspective is that the campus is an "academic place." Its primary purpose is to facilitate the teaching/learning process. And it's set up to do that. Whereas, at home, apartment, residence hall there are many distractions (TV, stereo, telephone, refrigerator, friends, parents, young siblings, etc), on campus there are lots of resources (professors, other students, places to study, tutors, etc). Suggest that students view their engineering study as they would view a "job," in that they would go there and do the greater share of their work there, perhaps bringing some work home, but certainly not all.

Spend some time getting their response to this "new knowledge." Try and get them to agree to try it and then assign them to operate in this manner for one-week. Afterwards spend some time processing what happened. Did it work? Why?

Objective 3F. Other study skills
Important other study skills can include:

Note taking
Analytical problem solving
Reading for comprehension skills
Memory skills
Questioning skills
Preparing for lectures
Preparing for tests
Test taking strategies

There are almost too many to deal with. All are important. Most would yield to the Five-Step Pedagogy. For example, if you feel that "Preparing for Lectures" is important, you can give students the opportunity to experience it through the Five-Step Pedagogy.

Becoming proficient at preparing for and taking tests is certainly paramount. Have students read Section 5.3 "Preparing For and Taking Tests" (pages 186-188) in *Studying Engineering, 3rd Edition*. Conduct a brainstorming session in class on this subject. You'll find your students as a group have lots of good ideas about this one.

There's lots of "technology" out there on the subjects of reading skills, memory skills, note-taking skills, and problem solving skills. The coverage of reading skills, analytical problem solving skills, and note-taking skills has been expanded significantly in the 3rd edition of *Studying Engineering*. Give students an assignment to do an Internet search on these subjects and make a short presentation to the class on what they learned.

Objective 4A. Understanding of self
Unlimited stuff here. Students can learn about themselves in relation to the various frameworks presented in Chapter 6 of *Studying Engineering, 3rd Edition*. These include:

Maslow's Hierarchy of Needs
Importance of Self-esteem
Meyers-Briggs Type Indicator (MBTI)

Ultimately, a good objective is that students have a "growth" mindset. If you're really interested in this stuff an excellent new book is *Mindset: The New Psychology of Success*, by Carol S. Dweck. The basic tenet of this book is that:

> *Everyone has one of two basic mindsets. If you have the fixed mindset, you believe that our talents and abilities are set in stone—either you have them or you don't. You must prove yourself over and over, trying to look smart and talented at all costs. This is the path of stagnation. If you have a growth mindset, however, you know that talents can be developed and that great abilities are built over time. This is the path of opportunity—and success.*

I often start my Introduction to Engineering course by asking: “How many of you want to change something about yourself?” Generally, about three hands will go half way up. And I’ll ask each of those who raised their hands: “What do you want to change about yourself?” They might relate: “I’d like to write better.” Or “I’d like to get along better with people.” Or “I’d like to stop procrastinating.” Generally other students will “get with the program” and share things they want to change. Invariably there will be some students who say “I don’t want to change anything.” These are the ones with the “fixed mindset.” Tell students that “change” is what this period in their life is all about, that the more they grow/change/develop, the better. I typically reinforce this idea over and over by starting each class by asking: “Who can tell me something they’ve changed? Either something you’ve done differently (behaviors) or something you’ve thought about differently?” Eventually, students become enthusiastic about having something to share.

Group Discussion on Attitude

One step in understanding of self is the understanding of the importance of strongly held attitudes and beliefs. A useful exercise to help students take responsibility for their attitudes is to divide your class into small groups and have each group discuss the following quote from Charles Swindoll, Calgary Chapel, Orange County California.

> ***ATTITUDE***
>
> "The longer I live, the more I realize the impact of attitude on life. Attitude to me, is more important than facts. It is more important than the past, than education, than money, than circumstances, than failures, than successes, than what other people think or say or do. It is more important than appearance, giftedness, or skill. It will make or break a company, a church, a home.
>
> The remarkable thing is we have a choice every day regarding the attitude we will embrace for that day. We cannot change our past. We cannot change the fact that people will act in a certain way. We cannot change the inevitable. The only thing we can do is play the one string we have, our attitude.
>
> I am convinced that life is 10% what happens to me and 90% how I react to it. And so it is with you. We are in charge of our *Attitudes*."

This can be followed by the doing the general exercise for working with students to become conscious of negative attitudes and changing them presented in the section on “New Attitudes” on pages 24-29 of this *Guide*.

A number of instructors of Introduction to Engineering courses have found it productive to have students take the Myers-Briggs personality test. Your students may be able to take the test at your counseling center or your career center. Even easier is to take basically the same thing in the form of the Keirsey Temperament Sorter-II Personality Instrument on line at:

http://www.advisorteam.com/temperament_sorter/register.asp?partid=1
The instrument requires making one of two choices on 70 very revealing items. It is free to take the test and to get some limited results. Complete results cost $14.95 (well worth the cost).

Have students write a paper on what they learned about themselves by taking this test or have a discussion in class on the same subject. Another fun thing to do is for you to print out the questions and do an in-class survey by having a show of hands on each item. In this way, students can learn about themselves and about their fellow students.

Recently, I gave a guest lecture at an Introduction to Engineering course at which the instructor had asked me to address the Myers-Briggs Type Indicator (MBTI). I made a handout of the first 25 questions from the Keirsey Temperament Sorter-II Personality Instrument and had each student take a few minutes and complete it. Then by a show of hands we surveyed the students on each question. The class was split almost evenly on each of the items. For each question, we discussed the implications of being one way or the other for effectiveness as a student and as a practicing professional, particularly what happens when people having different types work together. Lots can be learned by examining the two sides of a question like:

Do you feel better about:

Keeping your options open
Coming to closure

Objective 4B. Self-confidence and self-esteem
Some students are overconfident and some students lack confidence. Both ends of that "spectrum" can be detrimental. Probably the two groups need a different message. Overconfident students need the "Look to the left; look to the right . . ." message and those who lack confidence need the "You can do it!" message. Maybe a little of both messages is ok.

For the students that lack confidence, you might try the following exercise from Richard Felder of North Carolina State.

Imposters Everywhere

If there's one trait that characterizes most engineering students in their first semester of college, it is insecurity. With very few exceptions, they're nervous about almost everything—living arrangements, social adjustments, finances, and more than anything else, how they will deal with the academic demands of college.

Most of them were successful in high school, getting good grades with very little effort. In their first weeks of college, however, they discover that almost everyone around them was also a high school hotshot, and they then begin to fear that they may be ***"impostors,"*** who have somehow faked their way into engineering school but who don't really have what it takes to compete there. For some of them, their level of insecurity can paralyze them on assignments and tests, causing their prophecies of failure to be self-fulfilling.

I have found that it helps freshmen a lot to tell them about this mental game that so many of them are playing on themselves. I have written a short paper called "Impostors Everywhere" that I hand out to freshmen in our *Introduction to Engineering* course about three weeks into the term. (Available on the web at: http://www.ncsu.edu/felder-public/Columns/Impostor.html) I spend about ten minutes in class summarizing the contents of the paper and then suggest that they talk to me or to their academic advisor if the paper raises any issues they would like to discuss.

Many of them later tell me that they found it reassuring to know they weren't the only ones struggling with those feelings. Gratifyingly, the paper induced a few of the worst "impostors" to seek counseling assistance—the best thing they could have done for themselves.

You might want to give it a try with your students.

Here is a personal development exercise that Dr. Ed Prather at the University of Cincinnati uses to help his students better understand themselves.

Self-Reflection Exercise

1. Do I like myself? Explain in what ways "yes" and in what ways "no."
2. How confident am I when I begin something new? In what ways do I feel confident and in what ways insecure?
3. What do I do best? What do I do poorly?
4. Am I pleased with the way I treat others? Explain in what ways "yes" and in what ways "no."
5. Am I pleased with the way others treat me? Explain in what ways "yes" and in what ways "no."
6. Am I pleased with the way I do my work? Explain in what ways "yes" and in what ways "no."
7. How do I describe myself to others?
8. Do I talk much about myself? How do I feel about being the topic of conversation, both when I initiate it and when I do not?
9. When I do discuss myself, what are the topics and contexts? Who are the other participants in the conversation?
10. In what areas do I report myself favorably and in what areas unfavorably?
11. Do I believe what I say about myself? Explain in what ways "yes" and in what ways "no."
12. What are the characteristics of others whom I find attractive? Explain how these characteristics are attractive.
13. What are the characteristics of others whom I find unattractive? Explain how these characteristics are unattractive.

Students are asked to prepare a written response to these questions as a homework assignment. In class, students pair up and discuss their written responses. Next a general class discussion focuses on finding commonalities. The purpose is to identify behaviors and attitudes that inhibit success and need to be changed.

Objective 4C. Self-assessment

Many of your students are experts in "avoidance behavior." "Avoidance behavior" is the enemy of the growth mindset. Through avoidance behavior, the student tends to move away from areas of weakness, thereby preventing any growth or development in this area. If a person is shy, they avoid people, and therefore don't get practice in interpersonal relations or interpersonal communication. A poor writer avoids writing, ensuring that their writing skills don't improve.

Through self-assessment, a student can identify areas of strength and areas that need improvement. Have students read Section 6.5 "Assessment of Your Strengths and Areas for Improvement (pages 231-233) in *Studying Engineering, 3rd Edition*. Assign them the problems related to this subject at the end of Chapter 6: 20, 21, 22, 25, 27, and 30. Require students to put together written personal development plans in all areas that are identified as "Areas for Improvement." Review those plans and give specific feedback.

Objective 4D. Wellness and stress management

Lots of subjects here. Among them are:

Nutrition
Exercise
Substance abuse (alcohol/drugs)
Sexually transmitted diseases
Mental health
Stress management

You may wonder why these subjects are appropriate to an Introduction to Engineering course. Good question. My only answer is that they can have a significant impact on engineering student academic success and that they are probably not dealt with any other place in your students' experience.

All can be addressed through a variety of approaches. Most are issues students know about to one extent or another, so brainstorming and class discussions can be illuminating. There is some limited material (particularly on stress management) in *Studying Engineering, 3rd Edition* and I expect to expand the coverage of some of these subjects in any future edition. Have students read what is there and comment on it. If time permits, there are certainly "experts" on your campus in most of these subjects, either in specific departments (e.g., psychology, educational psychology, physical education) or in the counseling center and/or student health center that you could bring in.

Objective 4E. Respect for and interaction with others

The section in *Studying Engineering* on "Understanding Others/Respecting Differences" is the one I am proudest of because it was hardest to write. I showed my first draft to my wife and she exclaimed: "You can't say these things." But I believe after much revision, I was able to capture both the key points as well as the spirit of this topic. I would hope you would make a particular point of getting your students to engage this section of the book.

“Stereotyping” can be a fun subject to explore. If you’re bold conduct an exercise in which you have your class brainstorm all the “stereotypes” they know of related to several ethnic groups (e.g., Italians, African-Americans, Mexican-Americans, White-Americans). Record the list on the board in the front of the room. Once you have the list up there. Ask the class: “Where did this list come from?” They’ll try and say that it’s not what they think, but what others think. But who came up with the list? They did! This is a good way to show them that they are very likely approaching individuals within each of those ethnic groups from the perspective they put forth. The ultimate lesson is not to “make up” things about people that may in fact not be them at all, but rather approach each individual from the “all things are possible” perspective.

Once again, there are very likely “experts” in cultural awareness and cross-cultural communication on your campus who you could bring in to do some training with your students.

Objective 4F. Management of personal life

Effective management of the many aspects of a student’s personal life will be a critical factor in their success in engineering study. Among those factors that are most important are:

Family
Friends
Work
Living arrangement
Finances

The first four of these are addressed to a limited extent in Section 1.5 “Structure Your Life Situation” (pages 23-27) in *Studying Engineering, 3rd Edition*. There is nothing specific in the book on “personal finance.” Have students read this section and lead a class discussion of what was learned. Experience has shown that even this limited guidance can bring about significant change on the part of students. This change can manifest itself in things like reducing hours worked, negotiating agreements with parents and friends, and changing living arrangements.

There is really no great knowledge to bring to bear here. More a matter of getting students to take a hard look at their situation. They know the answers. They may very well have just “had their head buried in the sand.”

Objective 5A. College of Engineering

Objectives 5A and 5B are related to the overall objective of “Orientation.” In it’s most useful sense “Orientation” is really about empowering students by teaching them that the system can either:

1) do things to them
2) do things for them

And that the difference has mostly to do with how they go about things. Do they understand how the system works? Do they know how to interact with people to get what they need and want from them?

How students operate is generally related to their "world-view" relative to "locus-of-control." The following is a discussion of how to address "locus-of-control" in the context of an Introduction to Engineering course excerpted from an article in *Success 101* by Milton Randle of Cal Poly Pomona.

Locus-Of-Control

Most college students know they should practice discipline, work hard, sacrifice and set priorities. So why don't they? If they truly want to succeed (as they say they do when I ask them in class), what gets in the way of so many of them? The simple answer is: *They get in their own way.* The hard part is: how do we as teachers of "student success" courses help students get out of their own way and point them in the right direction? Solution: We teach them about their *Locus-of-Control*.

"Locus-of-Control" (LOC) is a psychological term for the personality trait that explains how we attribute control in our lives. Psychologist J. B. Rotter (J. B. Rotter, "Internal Control-External Control," *Psychology Today*, v. 1, p 39-43, 1971) used the term "Locus-of-Control," (i.e., where one's sense of control is located), to explain how an individual behaves in relation to how he feels about himself and his external environment. Internal LOC means that the individual believes he is in charge of his life. External LOC means that the individual believes that something or someone other than himself is in charge.

The following sections outline a step-by-step pedagogy for assisting students in seeing themselves as the creators of their life.

We introduce our students to the concept of LOC by first having them take one of the "Locus-of-Control" assessments available on the web (See: http://www.dushkin.com/connectext/psy/ch11/survey11.mhtml. A high score indicates a tendency toward an internal locus-of-control and a low score indicates a tendency toward an external locus-of-control. The scores measure the degree to which the students' external LOC is based upon chance factors and/or the power of others.

We stress that the results are not absolutes. They are to be used as a tool for awareness. Most importantly, the students begin to develop terms for how they think about themselves and how their thinking influences their college experience.

> *"It is not necessarily a matter of who or what is in control of our lives; it is what we feel or believe about being in control."*

Next students are given a writing assignment in which they are asked to discuss: What the LOC scores tell them about their sense of control and responsibility in their lives. What they think they need to do to exercise more control for their actions, and why. Simple in its postulation, the concept affords students a new way to look at themselves and life. Writing about it helps them to gain deeper level of comprehension about LOC and to internalize the process. We caution the students to not write about anything with which they are uncomfortable. Yet, I am always surprised at how easily students relate to discussing their control issues. They readily disclose very personal experiences about the control factors in their lives.

Chapter 8 of *Studying Engineering, 3rd Edition* provides students with an orientation to the engineering education process including a perspective on the very important subject of academic advising. This can be supplemented by specific information about various aspects of your engineering program including curriculum, facilities, leadership, faculty, and other student resources.

Objective 5B. University

Much of the material in Chapter 8 of *Studying Engineering, 3rd Edition* provides students with an orientation to the various academic regulations they will need to know in order to make them work for them.

Providing information about the various other resources available within the university can be helpful. Some speakers or panels of speakers may be useful for this purpose. Previously mentioned “Scavenger Hunts” may make this orientation even more useful and fun at the same time.

Administrative Issues

The previous sections have detailed five primary objectives that if accomplished will significantly improve the academic performance and retention of freshman engineering students. However, achieving these objectives requires adequate contact time and adequate incentives to guarantee serious student participation.

Contact Time. There is no definitive answer to how much contact time is required. In my experience, 25 contact hours would be ideal. At Cal State L.A., which is on the quarter system, our ENGR 100 Introduction to Engineering course was a 1-credit hour laboratory course that met for 1 hour and 15 minutes twice weekly for ten weeks (25 total contact hours). The sample syllabus in Appendix A indicates that would be accomplished in 20 one-and-a half hour sessions. I have, however, talked with people who felt that they had been able to accomplish quite a bit in six, 1-hour sessions. Their approach was to have students read a chapter of *Studying Engineering* and devote the class to processing what was learned from the reading.

Incentive/Grading. In terms of incentive, it is doubtful that any other than academic credit will motivate the desired level of student participation. Where universities have attempted to orient their students through voluntary activities, attendance has been extremely poor. Even incentives such as scholarships, priority registration, and summer jobs in industry have not been able to compete with an upcoming calculus exam for students' time.

Ideally the course would be for “grade.” We have ways of sending students signals about what is important and what is not important. Offering an Introduction to Engineering course on a Pass/Fail or Credit/No Credit basis sends the message that this course is not important. And certainly giving a grade gives you much more leverage in getting students to do the work you assign. Since much of the benefit of the Introduction to Engineering course described in this Guide comes from the in-class group activities, I would encourage you to include attendance as part of the grade. I have felt so strongly about the importance of attendance, that students who had more than two absences (excused or not) did not receive credit for my course.

Class Size. Class size is an issue, especially in the current era of tight budgets in higher education. While smaller classes are preferable because they allow individual students greater participation, it is possible to run the course with large class sizes. Most instructors will find that every student need not take part in every discussion in order to raise all the key points in class. Even in a class of 30, it may take only ten students sharing their responses to certain issues to touch on all the important points, and the same holds for a class of 100.

Advocacy. Receptivity of faculty to giving academic credit for freshman orientation courses varies greatly from one institution to the next. At some institutions, faculty feel that such courses are not worthy of "academic" credit. At others, faculty resistance comes more from the practical problem of finding room in an already overcrowded curriculum. Those who bring a proposal for an "Introduction to Engineering" course to the academic approval process may find themselves defending the course against the undesirable alternatives of increasing the number of units required for graduation or eliminating some "absolutely essential" engineering content from the curriculum. The best that can be done is to put forth, as persuasively as possible, the argument that devoting one or two percent of the curriculum to improving students' effectiveness in learning the other ninety eight percent is a very wise investment.

During my NSF-sponsored Chautauqua short course "Enhancing Student Success Through a Model Introduction to Engineering Course," participants engaged in an exercise to develop both reasons for and reasons against such courses. One group of overly enthusiastic volunteers agreed to form the "dreaded curriculum committee" and spent time articulating their opposition. Five other groups spent time developing their points in favor. Presentations before the mock committee yielded the following pros and cons:

Reasons Given in Favor of Course	**Reasons Given in Opposition to Course**
View this as a "pilot" for one year. We want to try something new and innovative.	"Pilots" never go away.
Course will improve student learning in other courses.	Too much "coddling" students. What happens when this "crutch" is removed?
Course will improve student retention and help sustain strong enrollment.	No room in the curriculum. Will increase units to graduation.
Course will improve diversity of engineering students.	Maybe okay for non-traditional students. Why make all students take it?

Course recognizes the need to provide transition from high school to university.	Proposed course insults students' intelligence.
Course has been proven effective at other institutions.	Do you have hard data that shows these courses improve retention?
We will evaluate the effectiveness of the course.	We don't trust you.
Course will correct deficiencies in students that faculty complain about.	None of our faculty will want to teach such a course.
Course helps students choose their engineering discipline.	Instructor will try to sell students on his/her discipline.
Course will improve student satisfaction with their educational experience.	Attitudes of engineering freshmen are irrelevant.
Course is responsive to ABET Engineering Criteria 2000.	Why not integrate across existing courses (i.e., "student success across the curriculum")?
Course is responsive to what industry wants from engineering education.	If industry wants it, let them do it!
Course will lead to more effective use of $$ (i.e., less failure).	Why commit resources to something we don't believe will work?

As you can see, powerful and potentially persuasive points can be made on both sides. The purpose of including this information is to assist you in becoming an effective advocate for "student success" courses for engineering students. Effective advocacy requires not only the ability to articulate your case, but also an understanding of the opposition and an ability to address their concerns.

CONCLUSION

The fundamental tenet of this Instructor's Guide is that current engineering curricula devote 128 semester credit hours (192 quarter credit hours) or more to teaching students subject content, whereas very little time or effort is devoted to teaching students strategies for being effective at the process of learning that content. The current situation has parallels to learning a game of skill such as chess. One could learn how to conduct a game of chess in a relatively short time. However, by merely playing the game, improvement would be slow and ultimate level of mastery low. Mastery at a high level would require not only playing the game but also devoting considerable time to learning how to play. In like manner, not only do our students need to learn content, but also they need to learn how to learn and how to be effective learners. And the payoff for helping our students become effective as students is enormous. Not only will they perform better in our courses, the skills they need to be effective as engineering students are the same skills they will need to be effective during their engineering career.

An "Introduction to Engineering" freshman orientation course has proven to be an effective academic structure for providing these skills. Through the course, five objectives can be accomplished which will benefit students: 1) improve their peer environment; 2) teach them essential academic success skills; 3) assist them in their personal development; 4) enhance their professional development; and 5) orient them to the engineering college and the university. In meeting these objectives, we are in essence undergoing a paradigm shift—a shift from a paradigm where each student is left to "sink or swim" to a paradigm in which we assist each of our students in achieving all that he or she can. In the first case, we believe that many of our students will fail, and we are not surprised when they do. In the second case, we believe that <u>all</u> of our students will succeed, and we are surprised if one does not.

Appendices

A sample syllabus can be found in Appendix A. Eight sets of PowerPoint slides (one for each chapter in *Studying Engineering, 3rd Edition*) are shown in Appendix B. Four multiple-choice exams (one per two chapters) and solution key are included in Appendix C. All of the material in the appendices as well as the text of Guide is included in a CD Rom on the inside back cover.

CD Rom

A CD is included on the inside back cover. The CD includes the following in electronic file form:

Complete *Instructor's Guide*
Sample Syllabus
Eight PowerPoint presentations (one for each chapter)
Four multiple-choice exams (one per two chapters) and solution key